

CLAIMS

What is claimed is:

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1. An earth penetrating apparatus for use with a boring machine, comprising:
a cutting tool assembly comprising a cutting tool and a sensor housing;
a radar unit provided in the sensor housing;
an antenna arrangement coupled to the radar unit, the antenna

10 arrangement configured for transmitting and receiving electromagnetic signals in a relatively forward looking direction relative to a distal end of the cutting tool;

a rate sensor unit provided in the sensor housing, the rate sensor unit comprising one or both of a gyroscope and an accelerometer;

15 a processor provided in the sensor housing and communicatively coupled to the radar unit and the rate sensor unit, the processor receiving radar data from the radar unit indicative of subsurface strata and obstacles respectively located generally forward of the cutting tool and receiving displacement data from the rate sensor unit indicative of one or both of longitudinal and rotational displacement of the cutting tool;
and

20 a transmitter provided in the sensor housing and coupled to the processor, the transmitter configured for transmitting one or both of the radar data and the displacement data to an aboveground location.